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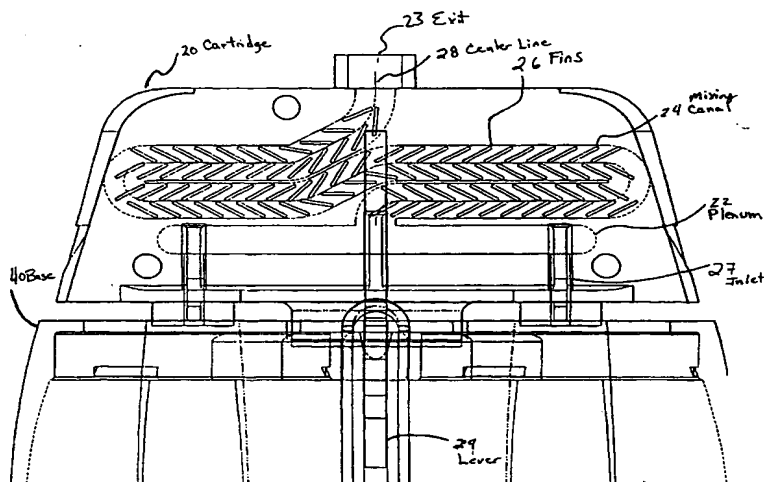
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[Continued on next page]

(54) Title: AEROSOL MIXING SYSTEM



(57) Abstract: A mixing system (Fig. 1) having a tip (10), cartridge (20), collar (30), base (40) and containers (50) is described. The tip is in communication with the cartridge. The cartridge contains a plenum (22) through which a plurality of constituents flow into a mixing canal (24) having a plurality of fins (26). The fins impart an improved mixing action in the constituent flow, allowing for more thorough and predictable mixing results. The collar is coupled to the cartridge, the base, and a plurality of the containers. The configuration provides for fluid communication as the plurality of constituents are passed from the containers to the cartridge, are mixed, and are then passed out of the tip. Variations in the geometry of the elements of the system suit a variety of applications. Similarly, by providing structure for varying the system geometries, the system may utilize multiple types of constituents for an even wider array of applications.

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AEROSOL MIXING SYSTEM

FIELD OF THE INVENTION

This invention relates to a system for mixing the outputs of a plurality of containers in a convenient, hand held device. Specifically, the invention employs a modular housing
5 suitable for production via injection molding, with at least two components including an internal mixing chamber contained internally within a cartridge. The mixing system is modular and has elements that are disposable from use to use.

Prior application PCT/US 99/18738, filed August 18, 1999 and U.S. Application 09/763,089 filed February 16, 2001, both of which are incorporated herein by reference,
10 teach embodiments of the mixing system known commercially as the MIXTEK dispensing system.

SUMMARY OF THE INVENTION

According to the present invention, an improved housing and baffle system are
15 provided. In this improvement, a plurality of containers are held securely within a housing that ensures proper actuation and thorough mixing of the ingredients using a mixing chamber/baffle chamber with angled fins. The construction is simple and economical.

The invention provides an attractive, pressurized, through-cap-controlled mixing technology. Generally, the system employs a dispensing head with an internal baffle
20 chamber that fits onto at least two pressurized sources of mixable products. At the press of a button, the ingredients in both containers are metered and mixed together in a controlled dosage in the baffle chamber and are then released through the dispensing/applicator head/tip. A primary advantage is that the ingredients are metered, mixed, and released and the user never has to touch the product. The separation of the products is maintained until

the precise moment of release. This is a distinct advantage for ingredients that must be separated until the moment of use, including hair coloring, hair relaxers, epoxies and resins, and the like. The MIXTEK System is designed to work with state of the art container technology including but not limited to barrier packs and all forms of compartmentalized aerosols. The innovative dispensing head/tip and cartridge can be used with either a single can or multi-can application. The entire unit is encased in a contour fitting housing made of plastic, rubber, or other suitable material.

The MIXTEK System provides great advantages over traditional bottles, jars, tubes, aerosols and pumps. The instant invention can be used for a variety of products and applications. In each case, the dispensing head/tip has been designed for the precise application of the particular product. After use, the user can clean the dispensing head/tip and baffle chambers. Alternatively, after use, select components or the entire system of containers and components are disposable.

Some of the applications for the inventive MIXTEK system are: hair coloring, hair relaxers, permanent waves, epoxies, automotive applications, gardening products, pharmaceuticals dispensing, controlled dose inhalants, pet and veterinary formulations, personal grooming, and post foaming products. Further objectives and advantages will become apparent from a consideration of the description, drawings, and examples.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is better understood by reading the following detailed description with reference to the accompanying figures, in which like reference numerals refer to like elements throughout, and in which:

Figure 1 is a side view of an embodiment of the assembled invention.

Figure 2 shows a side view of the cartridge element of Figure 1.

Figure 3 shows a cross-sectional view of the cartridge element of Figure 1.

Figure 4 shows a side view of the collar of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 In describing preferred embodiments of the present invention illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the invention is not intended to be limited to the specific terminology so selected. It is to be understood that each specific element includes all technical equivalents, which operate in a similar manner to accomplish a similar purpose. Each reference cited here is incorporated by
10 reference as if each were individually incorporated by reference. The term "a" is intended to mean at least one unless the context indicates otherwise.

A "container" may include any type of fluid container, including aerosol containers of the piston type using a polyethylene, polypropylene, or a more sophisticated polymer barrier structure molded or thermoformed as a piston disposed between a propellant such as
15 a hydrocarbon, compressed air (CAIR) or nitrogen, and a product to be dispensed. The containers may also be of the so-called bag-in-can type having an inner container such as a bag or pouch that attaches to either of the top seam of the can or the can curl. Generally, any other type of fluid container may be used with the device of the present invention. The type, size, shape and geometry of the containers used in the preferred embodiments disclosed
20 herein are neither critical nor essential aspects of the invention.

A "cartridge" may refer to a mixing chamber, a baffle chamber, a baffles chamber and generally includes a chamber or body through which thorough mixing of constituents is performed.

A "mixing canal" includes a tortuous or sinuous path, a channel, a mixing channel, a
25 baffle and generally includes any hollow through which constituents are passed and mixed.

A "tip" includes a dispensing nozzle, an applicator, a comb with voids through which constituents flow, an applicator head and generally any extension through which mixed constituents exit.

5 A "fin" includes a mixing station, mixing member and generally includes members within the mixing canal that interrupt the flow in the mixing canal to provide turbulent flow areas and thereby thorough mixing.

Figure 1 is a side view of an embodiment of the assembled invention. The system of the depicted embodiment consists of four basic components: a tip 10, a cartridge 20 (shown schematically), a collar 30 and a base 40 along with at least two containers 50 contained
10 within the base (shown schematically). The components are coupled to one another, preferably in a snap-to-fit fashion or by a similar friction fit method wherein the components may be disassembled without tools.

Variations in the order and placement of the components to suit specific applications are contemplated by the current invention.

15 Referring to Figure 1, the tip 10 contains and integrally holds the cartridge 20. The tip 10 is designed to be interchangeable with other tips or additional components by which its shape is modified, allowing its shape to fit the application. For example, in hair care applications an extension or attachment might be added to facilitate dispensing the hair care product through a comb or brush shaped applicator. Thus a wide variety of applicators and
20 attachments may be exchanged in place of a particular tip 10 or may be attached to the tip 10.

Figure 2 shows a side view of the cartridge 20 and Figure 3 shows a cross-sectional view of the cartridge 20 of Figure 1. Referring to Figures 2 and 3, the tip 10 integrally and/or internally holds the cartridge 20. One of ordinary skill in the art can appreciate that
25 the cartridge 20 may extend integrally or internally into additional components of the device

as design needs dictate. In this embodiment, the cartridge 20 has an internal geometry consisting of a plenum 22, a mixing canal 24, and strategically placed fins 26 within the mixing canal 24 that repeatedly mix the separate constituents in the mixing canal 24. Preferably, the mixing canal 24 is somewhere in the range of about 4" to 60" long, about 5 0.01" to 1.8" wide, and about 0.01" to 1.6" tall. It is appreciated by one of ordinary skill in the art that the dimensions of the mixing canal 24 may be increased to suit the application, constrained only by the limitations of the overall size of the device and the cartridge 20 therein.

The arrangement of the fins 26 has been calculated to induce the maximum 10 turbulence for thorough mixing of the constituents without producing excessive back pressure. The following fin variables can be adjusted to affect the mixing and back pressure of the system: height, length, width, spacing between fins, flexibility, material and surface smoothness. Preferably, the fin length is in the range of 0.01" to 1.5", the fin thickness is in the range of 0.001" to 0.1" thick, the fin height is in the range of 0.01" to 1.5" and the 15 number of fin pairs in the mixing canal is in the range of up to about 460 pairs. Additionally, the angle at which the fins protrude from the wall relative to a centerline of the mixing canal is preferably between 10 and 120 degrees.

The cartridge 20 is interchangeable and can be designed to match the characteristics of the constituents to be dispersed. For instance different viscosity constituents, foams, and 20 the like require various geometries and container pressures to provide thorough mixing within the mixing canal. In particular, the spacing, angle and dimensions of the fins 26 and the length of the flow path may be varied to suit the particular constituents. Additionally, a means for manually or automatically adjusting the geometry of the mixing chamber (not shown) to suit specific constituents may be provided. Further the container pressures may 25 also be varied dependent upon the application and the physical properties of the constituents.

Attached to the cartridge 20 is a lever 29 that protrudes downward on the inside of the device. This lever 29 may be of any shape, but is preferably a "J" shaped lever for actuation with the thumb. It is ergonomically designed to activate the release of the contents of the containers 50 into the plenum 22 in the cartridge 20 upon activation. This trigger has
5 been found to be especially helpful when applying hair products as it permits one-handed operation of the system during application of the fluid constituents. One of ordinary skill in the art will appreciate that additional methods of actuating the device can be achieved. For example, a rotating motion or "rocking" of the upper components, the same motion generated by the lever 29, can be imparted on the tip 10 by simply pushing or pulling the tip
10 10 or the collar 30 components.

Figure 4 shows a side view of the collar of Figure 1. The collar 30 connects the tip 10 and the cartridge 20 to the base 40 and containers 50 and also serves several additional purposes. The collar 30 captures the tip 10 holding the cartridge 20 on the top and the base 40 on the bottom. Its internal geometry has a "snap in area" for both containers 50. It is
15 designed to accept a range of container lengths and geometries that have the same cap dimensions. It also is designed to accept different length base system components. The collar 30 has a plurality of valve seats to accommodate a plurality of containers and provide a secure communication of the contents of the containers to the cartridge 20. Additionally, the collar 30 can be integrally formed with the tip 10 or the cartridge 20 or both, effectively
20 combining the top 10, cartridge 20, and/or the collar 30 as one piece to be affixed on the base 40.

Referring again to Figure 1, the base 40 is connected to the collar 30. The base 40 is designed to match the approximate length and diameter of the containers 50, although means for adjusting the base 40 to accommodate various lengths of containers 50 can be provided.
25 Molded-in, raised ribs in either a soft or rigid material provide grip sections (not shown) for

the user on the exterior surface of the base 40. Further, the base 40 is preferably provided with a rounded contour to fit comfortably in the hand of the user. The base 40 is sized to hold a plurality of containers 50, preferably two containers.

The preferred material for the production of the device is plastic. Although metals, rubbers, and ceramics may be used to produce the device or any combination therein may be for specific components of the device, depending on the application. The preferred production materials are polypropylene and polyethylene. Any suitable manufacturing process for a given material may be used to manufacture the device and its components. A preferred method of manufacture using plastic materials is injection molding. If soft materials are used for the raised rib area on the base they are preferably molded in polyurethane, silicone, or a similar material. If the device is to be reusable then the snap-to-fit tabs are overbuilt to be more durable and more accessible, as in conventional latching mechanisms.

The device is operated in the following manner: the base 40 is removed; the containers 50 are inserted; the collar 30 is snapped on; the cartridge 20 is snapped into the tip 10; and then snapped onto the collar 30. The device is now fully assembled and loaded with the necessary constituents. The base 40 is grasped, preferably from the side like a book binding, and the lever 29 is depressed. The lever 29 then activates, either directly or indirectly, the actuators on the containers 50 so as to release constituents into the system. The constituents are then separately passed to the plenum 22 and into the mixing canal 24 in the cartridge 20, in which thorough mixing of the constituents occurs. Thorough mixing is achieved by the fins 26 arranged to interrupt the laminar flow of the constituents, providing points of turbulent flow in the mixing canal 24 which mix the constituents. The mixed product is then ejected through the tip 10 for use in its intended application.

EXAMPLE 1

A specific example of this device is described below with reference to Figures 1 to 4. The device is used to mix two chemicals into a homogeneous mixture as the end user applies it. The chemicals are stored in two gas charged cylinders 50. When the device is actuated
5 the chemicals are released into the cartridge. The gas first enters a plenum 22, which leads to a mixing canal 24. The mixing canal 24 is fitted with fins 26 that agitate the two chemicals into one homogenous mixture. The shape and configuration of these fins 26 are further described below.

The mixing canal 24 is sized and shaped to comply with the physical parameters of
10 the constituent chemicals to be mixed. In particular the viscosity of the constituents, the charge present in the cylinders 50, and the degree of mixing required, which would in turn relate to the mixing canal 24 length and the number of fins 26, dictate the geometry of the mixing canal 24.

The adjustment of the viscosity of the two chemicals and the gas pressure in the
15 cylinders is performed to provide the same chemical flow rate from both gas cylinders 50 into the plenum 22. Alternatively, the chemical flow rate may be varied to provide mixing the constituents in some other ratio. The parameters to be matched are generally related in the following manner, the higher the viscosity of the chemicals, the larger the gas charge needed to provide a net chemical flow through the plenum 22 and into the mixing canal 24.
20 Preferably, the plenum 22 configuration is designed so that path length between the two air cylinders input ports 27 and the common exit port 23 into the mixing canal 24 are identical. Both flows of chemicals should preferably meet at the exit port 23 with the same flow rate and back pressure so that equal amounts of the two chemicals enter the mixing canal 24.

The height, width, length and number/size of fins generally describe the geometry of
25 the mixing canal 24. The geometry of the mixing canal 24 may be varied to provide a

suitable degree of mixing and a usable flow rate for the end user. The larger the cross sectional height and width of the mixing canal 24, the higher the flow rate. The larger the number of fins 26, the better the mixing and the longer the length of the mixing canal 24, but the lower the flow rate. The larger the fins 26 the lower the flow rate. The greater density
5 of fins 26, the lower the flow rate. The greater the incline of the fins 26, the better the mixing, but the lower the flow rate. Additionally, a multiple protrusion fin may be utilized to increase mixing, but would result in a reduced flow rate.

The fins 26 in this example are preferably about 0.015" (inch) thick, 0.150" long, and 0.150" tall, and are on about a 30 degree incline relative to the canal path centerline 28.

10 It is appreciated by one of ordinary skill in the art the thickness, length and height and angle of the fins are variable to suit the particular space constraints, as mentioned above, or to suit the application of the device. Particularly the angle of the fins may be varied a full 180 degrees within the mixing canal 24 relative to the centerline 28.

The fins 26 are positioned in counter positive pairs, positioned on opposite sides of
15 the canal centerline, oriented like a funnel. The mixing canal 24 is 0.186" wide, 0.160" tall, 5.3" long, and has 46 pairs of fins optimized for mixing the constituent chemicals. Two symmetrical mixing blocks form the canal, with half the canal depth formed on each. The fin 26 pairs are attached in the canal to alternating sides, so that when assembled, the fins 26 are interdigitated. The fins 26 in this example do not extend the complete height of the
20 canal, so at least three sides of them are exposed to the chemicals.

The mixing action is accomplished by repeatedly funneling the chemicals through and between the pairs of fins 26, which create turbulent flow areas on the far side of each fin. The turbulent flow areas create a series of edge effect vortices that converge. As the vortices converge, the constituents are mixed. When repeated, this action interrupts the
25 laminar flow of the constituents and thereby pulls the chemicals into a homogeneous

mixture through the turbulent flow areas. The combined effect of the series of turbulent flow areas created by the fins provides for the thorough mixing of the constituents necessary to produce the final homogeneous mixture for the given application. The driving force to perform the mixing is derived from the gas cylinder charge.

5 The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Nothing in this specification should be considered as limiting the scope of the present invention. The above-described embodiments of the invention may be modified or varied, and elements added or omitted, without departing from the invention, as appreciated
10 by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the claims and their equivalents, the invention may be practiced otherwise than as specifically described.

WHAT IS CLAIMED IS:

1. A mixing system comprising:

an outlet tip in communication with a cartridge and having an outlet, said cartridge including a plenum through which a plurality of constituents flow, a mixing
5 canal, a plurality of fins through which the plurality of constituents is mixed and an outlet coupled to the tip through which the mixed constituents are passed;

a collar coupled to the tip and the cartridge; and

a base with a plurality of containers coupled to the collar and providing fluid communication between the base and the cartridge.

10

2. The system of claim 1, wherein the coupled tip, cartridge, collar and base are releasably coupled.

3. The system of claim 1, wherein the cartridge further includes a lever to activate the
15 release of the plurality of constituents into the plenum and thereby mix the constituents in the cartridge to provide a final thoroughly mixed product comprised of the plurality of constituents.

4. The system of claim 1, wherein the cartridge geometry is adjusted to accommodate
20 the physical properties of the constituents.

5. The system of claim 1, wherein the varying physical properties includes viscosity.

6. The system of claim 4, wherein at least one of the height, width, number of fins, and
25 length of the mixing canal is varied.

7. The system of claim 6, wherein the mixing canal is in the range of about 4" to 60" long.
- 5 8. The system of claim 7, wherein the mixing canal is 5.3" in length.
9. The system of claim 6, wherein the mixing canal is in the range of about 0.01" to 1.8" wide.
- 10 10. The system of claim 9, wherein the mixing canal is 0.186" wide.
11. The system of claim 6, wherein the mixing canal is in the range of about 0.01" to 1.6" tall.
- 15 12. The system of claim 11, wherein the mixing canal is 0.160" tall.
13. The system of claim 4, wherein at least one of height, length, width, spacing and surface roughness of the fins is varied to modify the flow characteristics of the mixing canal.
- 20 14. The system of claim 13, wherein the fin length is in the range of 0.01" to 1.5".
15. The system of claim 14, wherein the fin length is 0.150" long.
16. The system of claim 13, wherein the fin thickness is in the range of 0.001" to 0.1"
- 25 thick.

17. The system of claim 16, wherein the fin thickness is 0.015" thick.

18. The system of claim 13, wherein the fin height is .01" to 1.5".

5

19. The system of claim 18, wherein the fin height is 0.150".

20. The system of claim 13, wherein the number of fin pairs in the mixing canal is in the range up to 460 pairs.

10

21. The system of claim 20, wherein the mixing canal has 46 pairs of fins.

22. The system of claim 4, wherein the system further comprises a means for varying the geometry of the mixing canal.

15

23. The system of claim 4, wherein the system further comprises a means for varying the pressure at which the plurality of constituents enters the plenum.

24. The system of claim 1, wherein the collar further comprises a plurality of valve seats
20 respectively sized to hold a plurality of containers.

25. The system of claim 1, wherein the cartridge further comprises a plurality of inlets proceeding to its plenum corresponding respectively to the plurality of constituents.

26. The system of claim 1, wherein the plurality of fins protrude from the wall of the mixing canal at an angle.

27. The system of claim 26, wherein the plurality of fins protrude from the wall at an angle relative to a centerline of the mixing canal of between 10 and 120 degrees.

28. The system of claim 27, wherein the plurality of fins protrude from the wall at an angle relative to the centerline of the mixing canal of about 30 degrees.

29. The system of claim 1, wherein the plurality of fins has at least three surfaces of each fin exposed to the plurality of constituents in the mixing canal.

30. A cartridge for mixing constituents comprising:

a plenum in fluid communication with a plurality of constituents;

a mixing canal in fluid communication with the plenum and into which the constituents flow and are mixed;

a plurality of fins disposed within the mixing canal to promote turbulent flow within the mixing canal; and

an outlet through which the mixed constituents pass.

31. The system of claim 30, wherein the cartridge is disposable.

32. The system of claim 30, wherein the cartridge geometry is adjusted to accommodate constituents having varying physical properties.

33. The system of claim 32, wherein the mixing canal is preferably in the range of about 4" to 60" long.

34. The system of claim 33, wherein the mixing canal is preferably 5.3" in length.

5

35. The system of claim 32, wherein the mixing canal is preferably in the range of about 0.01" to 1.8" wide.

36. The system of claim 35, wherein the mixing canal is preferably 0.186" wide.

10

37. The system of claim 32 wherein the mixing canal is preferably in the range of about 0.01" to 1.6" tall.

38. The system of claim 37, wherein the mixing canal is preferably 0.160" tall.

15

39. The system of claim 32, wherein at least one of height, length, width, spacing between fins, flexibility, material and surface smoothness of the fins is adjusted.

40. The system of claim 32, wherein the fin length is in the range of 0.01" to 1.5".

20

41. The system of claim 40, wherein the fin length is 0.150" long.

42. The system of claim 32, wherein the fin thickness is in the range of 0.001" to 0.1" thick.

25

43. The system of claim 42, wherein the fin thickness is 0.015" thick.
44. The system of claim 32, wherein the fin height is .01" to 1.5".
- 5 45. The system of claim 44, wherein the fin height is 0.150".
46. The system of claim 32, wherein the number of fin pairs in the mixing canal is in the range up to 460 pairs.
- 10 47. The system of claim 46, wherein the mixing canal has 46 pairs of fins.
48. The system of claim 30, wherein the plurality of fins protrude from the wall of the mixing canal at an angle.
- 15 49. The system of claim 30, wherein the plurality of fins protrude from the wall at an angle relative to a centerline of the mixing canal of between 10 and 120 degrees.
50. The system of claim 30, wherein the plurality of fins has at least three surfaces of each fin exposed to the plurality of constituents in the mixing canal.
- 20 51. The system of claim 30, wherein the plurality of fins includes multiple protrusions issuing at varying angles from each fin.
52. The system of claim 32, wherein the cartridge further comprises a means for
- 25 adjusting the geometry of the mixing canal.

53. A method of mixing a plurality of chemicals from pressurized containers comprising the steps of:

actuating a plurality of actuators to release a plurality of constituents;

5 separately passing each of the plurality of constituents into a cartridge;

passing the combination of the plurality of constituents over a plurality of fins, thoroughly mixing the constituents; and

ejecting the thoroughly mixed constituents.

10 54. The method of claim 53, further comprising the steps of:

inserting a plurality of containers into a base;

coupling the base to a collar;

coupling an outlet tip into a cartridge; and

coupling the collar and the outlet tip.

15

55. A mixing system comprising:

means for activating a plurality of actuators to release a plurality of constituents;

means for separately passing each of the plurality of constituents into a mixing cartridge;

20 means for passing the combination of the plurality of constituents over a plurality of fins and thoroughly mixing the constituents; and

means for ejecting the thoroughly mixed constituents.

56. In a mixing system including an actuator for the simultaneous release of materials from at least two containers to a mixing chamber in which a plurality of materials is combined, the mixing chamber having a channel through which the materials pass and at least one outlet port at which the mixture is dispensed, the improvement comprising:

5 a plurality of fins located within the mixing chamber and spaced apart to interrupt the laminar flow of the plurality of materials and thereby induce turbulent areas to provide thorough mixing of the plurality of materials.

57. The system of claim 1, wherein the plurality constituents flow at the same flow rate
10 from said plurality of containers.

58. The system of claim 1, wherein the plurality constituents flow at different flow rates from said plurality of containers.

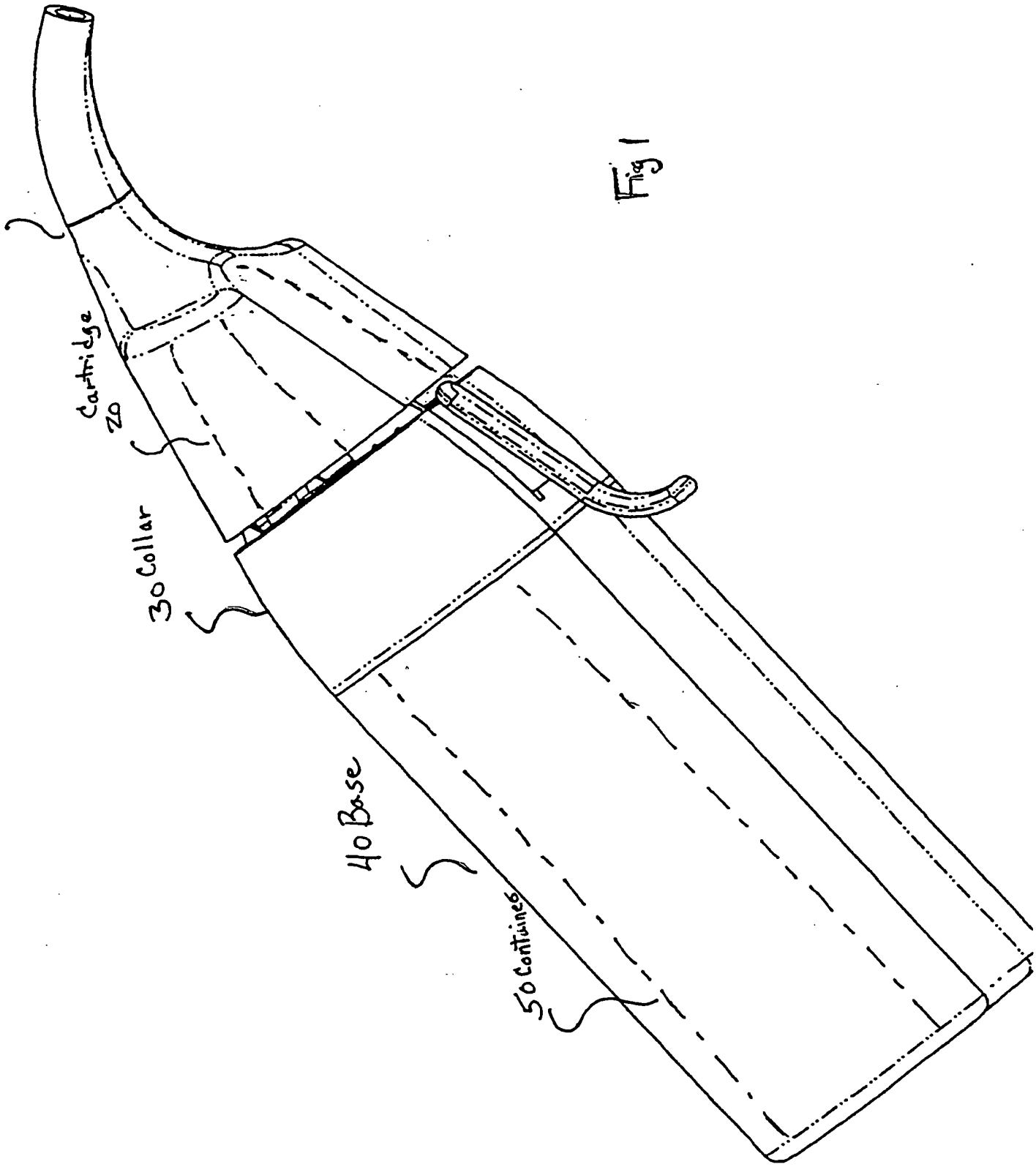


Fig. 1

Fig. 1

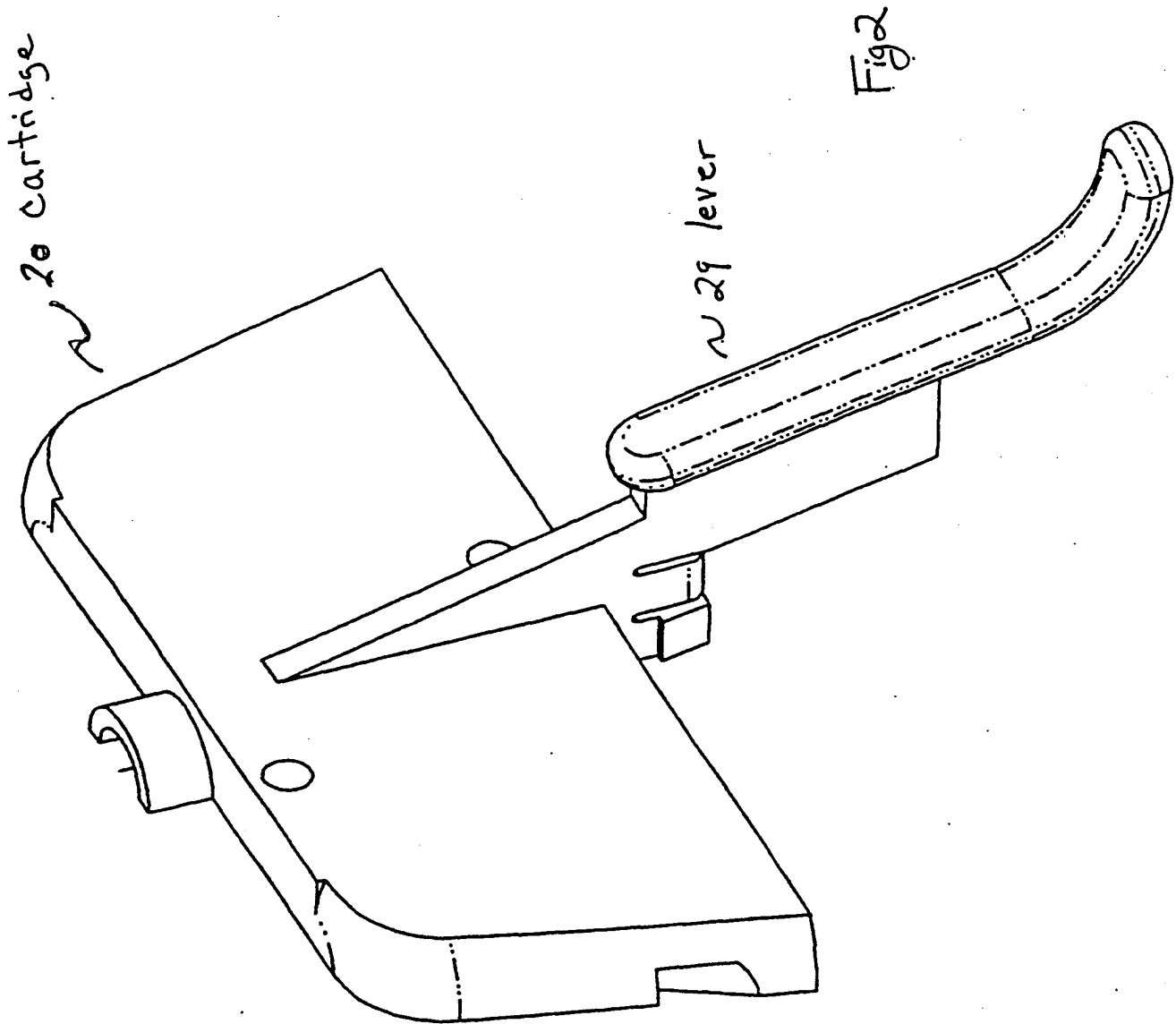
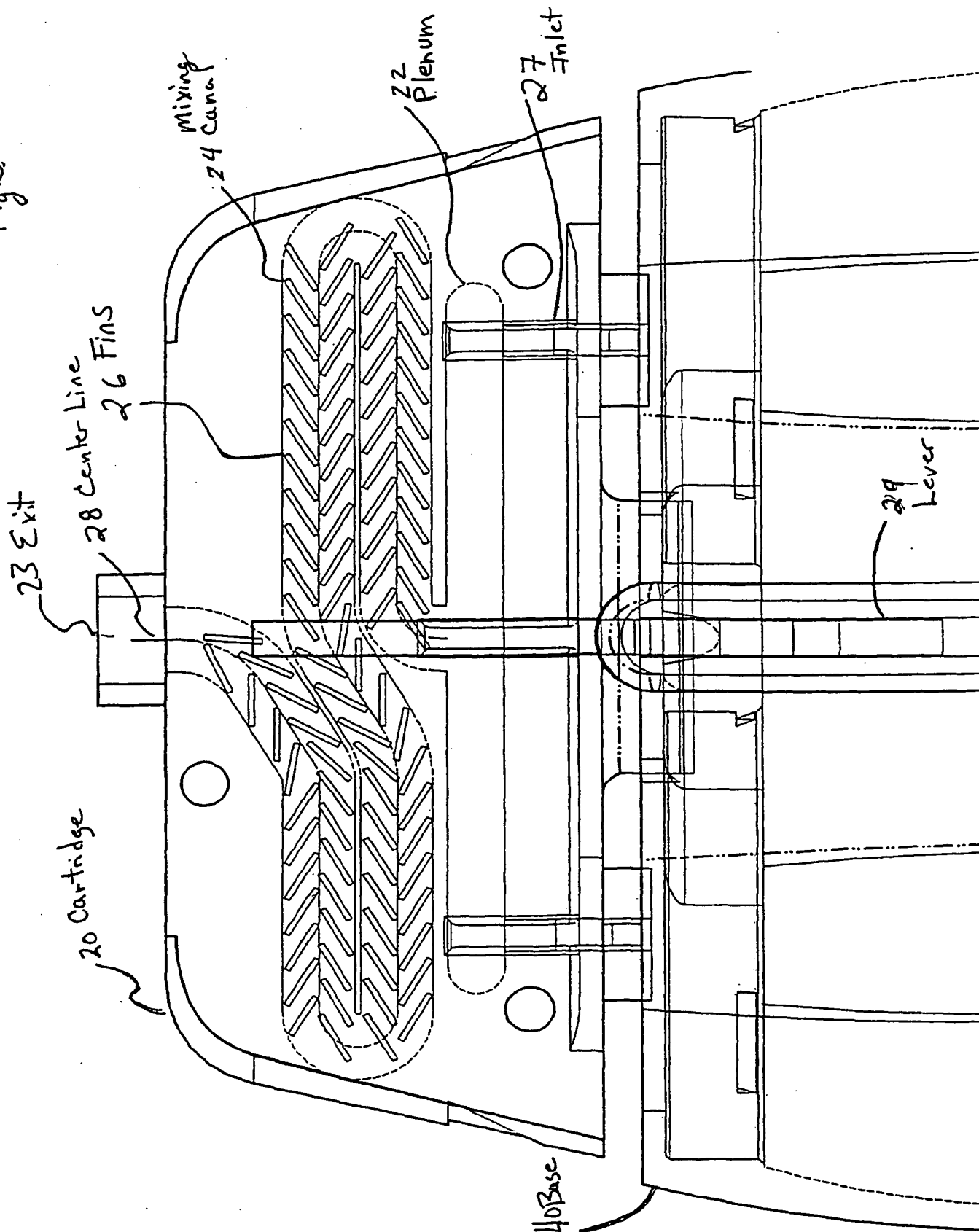
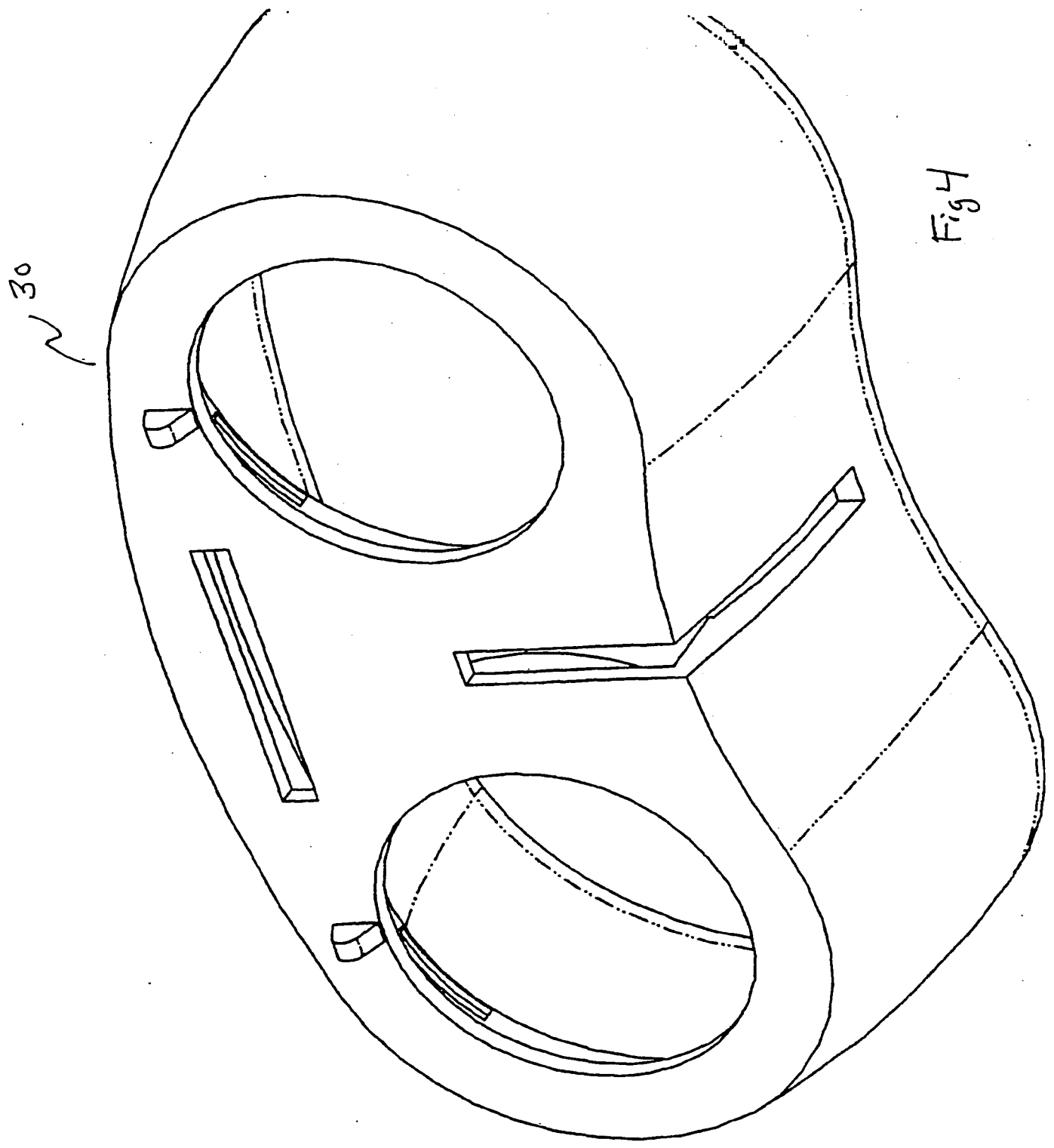


Fig. 3





INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/21007

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B05B 1/04
US CL : 222/145.5, 145.6

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 222/145.5, 145.6

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,092,492 A (CENTEA) 03 March 1992 (03.03.1992), col. 3, line 36 to col. 6, line 45.	30-31, 48-50, 53-56
A	US 3,575,319 A (SAFIANOFF) 20 April 1971 (20.04.1971), Abstract.	
A	US 3,633,795 A (BROOKS) 11 January 1972 (11.01.1972), Abstract.	
A	US 4,880,143 A (MURRAY et al.) 14 November 1989 (14.11.1989), Abstract.	

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

28 August 2001 (28.08.2001)

Date of mailing of the international search report

10 OCT 2001

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Telephone No. 703-308-0861

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/21007

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claim Nos.: 1-29,32-47,51,52,57 and 58
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Please See Continuation Sheet
3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

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- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/21007

Continuation of Box I Reason 2:

With respect to claims 1 and 2-29, 57, 58 dependent thereon, claim 1 requires that the collar (30) be coupled to the tip (10) and the cartridge (20). The collar (30) is disclosed and shown in Fig. 1 as being coupled to the cartridge (20), which in turn is coupled to the tip (10). Within the context of the drawings and disclosure, it is not clear what the claim limitation of the "collar coupled to the tip" means. Also, the claim requires "a base with a plurality of containers coupled to the collar and providing fluid communication between the base and the cartridge." The base (40) as disclosed does not provide fluid communication with anything, it simply retains the containers (50). Therefore, it is not clear what the above fluid communication limitation means.

With respect to claim 32 and claims 32-47 and 52 dependent thereon, claim 32 requires the cartridge geometry to be adjusted to accommodate constituents having varying physical properties. Support for this limitation is found on page 5, lines 22-24 which states: "Additionally, a means for manually or automatically adjusting the geometry of the mixing chambers (not shown) to suit specific constituents may be provided." However, the disclosure fails to show or teach how to make and use such an adjusting means. These claims are therefore not sufficiently understood to provide a meaningful search.

With respect to claim 51, the claim requires that the "plurality of fins includes multiple protrusions issuing at varying angles from each fin". However, the disclosure fails to show or teach how to make and use such fin protrusions. This claim is therefore not sufficiently understood to provide a meaningful search.

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